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EARTH RESOURCES TECHNOLOGY SATELLITE
FINAL REPORT

12. OBSERVATORY INTEGRATION & TEST PLAN & LAUNCH OPERATIONS PLAN

PREPARED FOR

GODDARD SPACE FLIGHT CENTER
NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION

UNDER CONTRACT NAS5-11260

TRW SYSTEMS GROUP

IBM FEDERAL SYSTEMS DIVISION

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Volume 12. Observatory Integration and Test Plan and Launch Operations Plan

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prepared for

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PREFACE

The final report for the ERTS Phase B/C study consists of the 12 volumes that are submitted now and additional volumes to be delivered in April covering the results of the study of the Ground Data Handling System for ERTS. The contents of the first volumes of the report are as follows:

Volume

1. (to be completed in April). Summarizes all significant conclusions of the study and indicates where the supporting analyses are presented. The system specification is included as an appendix.

2. (to be completed in April). Contains all system interface studies.

3. Describes the design of ERTS resulting from the study, to a block diagram level of detail.

4. Presents the detailed results of the study supporting the design in Volume 3, including backup tradeoffs and analyses.

5. Presents both the design of the data collection system and the supporting analyses.

6-12. Present the plans prepared for the ERTS Phase D program on the Phase B/C program.

CONTENTS

OBSERVATORY INTEGRATION AND TEST PLAN

LAUNCH OPERATIONS PLAN

1. INTRODUCTION

This section contains a summary of the spacecraft/observatory test management plan, an outline integration and test plan, facilities, and equipment necessary to accomplish program objectives resulting from the ERTS study contract. Outlined herein are:

- Subsystem level tests required as each subsystem is integrated on the spacecraft
- Payload integration and test
- Pre-environmental tests
- Post-environmental tests
- Final payload, spacecraft tests, and alignment checks prior to shipment to the launch site.

Also presented is a summary of the test management procedures and the test equipment and facilities planned for implementation of the test program. Part II, Volume 17 of the proposal presents the complete plan.

1.1 GENERAL DESCRIPTION AND FLOW DIAGRAM

1.1.1 Introduction

A building block philosophy is utilized during integration of subsystem assemblies into the spacecraft which, coupled with methodical testing and monitoring, assures mutual compatibility and proper operation of each subsystem. Integration tests can be categorized into those which (1) examine the proper operation of a subsystem or subassembly as an entity, and (2) establish that no interference exists between subsystems or units. Consequently, as the spacecraft is built, tests are performed in a continuous and controlled sequence, verifying that the newly added subsystems do not interfere with, or degrade performance of, those already installed.

1.1.2 Observatory Integration and Test

Approximately two months before starting the ERTS-A electrical integration and test cycle, it is planned to perform a series of engineering tests on the RF subsystems. Engineering models and/or prototype

units of the USB, VHF, and wideband video subsystems will be connected in a bench set-up and the integration procedure performed as well as additional engineering tests. These tests are necessary for the following reasons:

- Points out subsystem and unit incompatibilities before integration on the flight spacecraft
- Helps validate and debug the newly designed EGSE
- Provides procedure debugging before use on the flight spacecraft thereby saving time.

As each subassembly is installed in order, it is integrated in accordance with detailed step-by-step written procedures with safeguards utilized to protect each subassembly from damage during the process. The interconnecting harnesses contain one or more test plugs which bring various critical interface test points out to a readily accessible area of the spacecraft. These test points are monitored during the entire installation and preliminary checkout process. Interference tests are performed to ascertain the type or magnitude of any noise generated from within the subassembly, i.e., switching transients, logic noise, and any improper operation caused by noise from any subassemblies. The tests are again performed in accordance with detailed step-by-step procedures. Improper operation is thus isolated and corrected before proceeding into more complex system testing. Payload interface equipment, i.e., junction boxes and harnesses are installed and checked. The payload is operated with stimuli and data is evaluated to ascertain that the payload is operating properly. At the completion of the subsystem and payload installation sequence, a compatibility test is performed in an anechoic chamber with all payload and spacecraft equipment operating. This test is performed on ERTS-A only. After compatibility has once been established on ERTS-A, it is not necessary to repeat the test on ERTS-B.

Two sets of alignment checks are performed. The first provides dimensional data for the spacecraft box. It also is the means for aligning the horizon scanner, yaw gyro, ACS jets, ΔV jets, RBV cameras, and

the MSS. Final alignment checks performed later determine if any structural part of the spacecraft has suffered from environmental test loads and verify that critical alignments have been maintained.

1.1.3 Observatory Test and Evaluation

Upon successful completion of the payload integration tests and alignments, the spacecraft proceeds into final assembly testing. These system level tests are categorized into three general phases: pre-environmental systems test, environmental test, and post-environmental system test.

1.1.3.1 Pre-Environmental Systems Test Phase

The first test phase, defined as the pre-environmental systems test block, consists of integrated systems tests supported by special subsystem and payload checks. This group of tests is performed prior to initiation of the environmental test phase and is designed to provide a very comprehensive baseline for comparison with data obtained upon completion of the environmental test phase. These tests are outlined in paragraph 4.2.

1.1.3.2 Environmental Test Phase

In the second test phase two distinct levels of environmental testing are used: design qualification and acceptance. The design qualification test program consists of a complete sequence of environmental exposures wherein ERTS-A is designated proto-flight spacecraft and is subjected to stresses 1.5 times acceptance levels with test durations the same as acceptance. Their purpose is to demonstrate the soundness and flight worthiness of design. The acceptance test program is comprised of a sequence of similar tests wherein flight system items are subjected to environments which are not to exceed those expected during the operational life of the satellite.

The purpose of the latter program is to demonstrate freedom from workmanship defects and verify that specified performance requirements are met. The major acceptance tests are vibration, acoustics, and thermal vacuum/solar simulation exposure. Before and after these tests, integrated systems tests are performed to assure that satellite performance has not been degraded.

1.1.3.3 <u>Post-Environmental System Test Phase</u>

This third test phase is concerned mainly with the repetition of a large portion of the system tests conducted prior to the environmental phase. Thus, a very detailed and comprehensive analysis of the effects of the environmental exposure on the satellite can be accomplished. At the completion of this evaluation, an additional series of tasks are appended to this test block. These consist of final satellite launch preparations which are conducted in the plant rather than at the launch site permitting reduction of launch operations to approximately four weeks.

2. SYSTEM TEST MANAGEMENT

2.1 INTRODUCTION

This section provides a description of the management procedures to be used in directing and controlling the integration and test program.

2.2 ORGANIZATION RESPONSIBILITIES

The ERTS project office provides overall direction and review of test planning, test operations, and test reporting through an assigned test director. The manager for spacecraft assembly, test, and launch, or his designee, is the test director responsible for the direction and review of the mechanical ground support equipment (MGSE), system test sets (STS's), and spacecraft systems test programs. The manager for system engineering is responsible for the overall test program to ensure that all specification performance requirements and mission objectives are satisfied.

The next level of organizational responsibility lies with the project manager for test equipment and spacecraft system integration and launch. The manager serves as test manager in his assigned area of responsibility. As such, he is responsible for the planning and implementation of the observatory respective test program. The test manager is responsible for obtaining the necessary test resources from his functional management in terms of assigned test conductors, test support personnel, test equipment, and facilities and has overall management responsibility for the planning and conducting of the test plans.

The assigned test conductors, (one for electrical tasks and one for mechanical tasks,) are responsible for the detailed implementation of their assigned test responsibilities, including the preparation and control in accordance with Section 2.2.5 of detailed test procedures and the planning of the test equipment and facilities requirements. The test conductor is also responsible for the conduct and reporting of the test in accordance with Section 5.

To assure compliance with quality, reliability, and test monitoring and control requirements, the performance assurance organization provides malfunction reporting and analysis, conducts failure review

board activities, participates in the various test review boards, and provides monitoring and review of test functions. In addition, the quality assurance organization is responsible for providing qualified test surveillance personnel for all testing. The safety organization provides safety requirements, constraints, and review to ensure the incorporation of effective system and personnel safety requirements.

2.2.1 Test Planning and Operations

The initial task is the preparation of the final article test plan in accordance with ERTS requirements. In this phase, the specification requirements are translated into test plans in each of the respective areas. These test plans provide a sequence of tests, test descriptions and purpose, and test schedules. The final article test plan is then reviewed by the responsible manager for observatory system integration and test and submitted to the GSFC/ERTS project office for approval. In the interim, as test requirements become more specific, further detailed plans may evolve.

The next step in the sequence involves the test implementation which includes the generation and review of the detailed test procedures, the initiation of test resource planning, and final test preparations. At this point and with an approved test procedure, test operations are initiated. If the test is composed of a series of test sequences, each requiring a special test set-up, then a post test review board (TRB) is convened by the test manager at the completion of each sequence. The purpose of the review board is to provide a review of the data versus the acceptance/rejection criteria and to decide whether to proceed to the next test sequence. If the decision is made to reject the test, retest requirements are defined; if not, the test set-up is broken and preparations are made to proceed to the next test sequence. This process continues until the entire test sequence is completed. Test reports are prepared and submitted as required.

Throughout the conduct of the test operations, the test conductor and the quality assurance representative are responsible for maintaining the required documentation. Throughout the test program, the responsible test director maintains daily contact with the test manager to provide direction, assistance, and judgment. The manager

for systems engineering, as well as the responsible performance assurance function, will provide review of the test results in comparison to system requirements.

2.2.2 Test Review Board

A joint system test review board will be established ensure close coordination of contractor and government understanding of the validity, technical adequacy, and certification of system tests.

2.2.3 Test Criteria

Deterioration or change in performance of any test article (part, subassembly, subsystem, and spacecraft) that in any manner prevents the test article from meeting functional, operational, and performance or design requirements throughout the specified life will constitute a failure.

If a failure or an out-of-tolerance performance anomaly as defined above occurs during a system test, the test sequence will be continued only upon approval by the GSFC/ERTS project senior test representative. A failure (including design or fabrication defect) will be corrected and the test repeated unless otherwise specified by the GSFC/ERTS project office. Every anomaly or failure will be noted and reported in accordance with GSFC/ERTS specification requirements.

2.2.4 Test Procedure Control

The configuration management office is responsible for the release of all test procedures and is established as the procedure control point. Authority for release of system level test procedures has been delegated to the manager for integration and test. Procedure control is defined in the ERTS "Configuration Management Plan."

2.2.5 Test Record Sheet

The test record sheet (TRW form 771) is used during the conduct of spacecraft system tests to document any deviations from the test procedure which is not covered by either a procedure change order (PCO) or a test change records (TCR) as defined in the ERTS management plan. It is maintained by the responsible quality assurance representative and becomes a part of the test data packages. For a formal test, all deviations must be corrected by procedure change order, test change record, or test review board action.

2.2.6 Test Equipment Management

The manager for integration and test is responsible for implementing the above requirements for the ground support equipment.

2.3 TEST PERSONNEL RESPONSIBILITIES

2.3.1 Test Director

The manager for spacecraft assembly, test, and launch is responsible for the development, review, and approval of the overall spacecraft final article test plan. As test director he is responsible to interface with the equivalent NASA/GSFC test director to establish, review, and approve the test plan and, as required, departures from the plan. The manager or his designated alternate acts as a member of the test review board.

2.3.2 Test Manager

The test manager (manager, integration and test) is responsible for the formulation and implementation of a complete system test program. He is responsible for direct supervision of the following disciplines within the subproject: test crews, test planning (electrical and mechanical), test facility interface, software development, EGSE calibration and maintenance, test procedure preparation (system level), integration, planning, and logistics (IPL) support, subproject budget control, and subproject design support. The test manager is responsible to coordinate the overall test planning activities with the test director.

The test conductor is assigned primary responsibilities for the conducting of all spacecraft electrical and mechanical test and handling operations. He (or his designated alternate) is the sole point of authority on the floor during formal test activities. He is responsible for assigning test crew personnel to each test. In addition, the test conductor is responsible for providing timely inputs for all test procedures to the work package manager for procedures, and for maintaining the EGSE, MGSE, and required capital test equipment in current calibration, for monitoring the spacecraft log book, and for providing inputs to the system anomalous performance record that is maintained by quality

assurance. The ERTS program will have an electrical test conductor responsible for electrical tasks and electrical crew, and a mechanical test conductor responsible for mechanical tasks and mechanical crew.

2.3.3 Quality Assurance

Quality assurance (QA) personnel are assigned to the systems integration and test crew team by the quality assurance project manager. These personnel do not report to or respond to direction from either the test director, test manager, or test conductor.

2.3.4 Test Schedules

The integration and test subproject is responsible for the generation of monthly test planning schedules covering activities on the spacecraft currently undergoing system test operations. In addition, the subproject publishes weekly schedules for internal coordination and review. Copies of these schedules are forwarded to NASA/GSFC representatives at TRW and GSFC.

2.3.5 Test Configuration

The test configuration will be as defined in the appropriate configured article list (CAL) as defined in the ERTS configuration management plan. The list will be published prior to each formal test and will define the exact configuration down to the black box level.

2.3.6 Test Procedures

The preparation, release, and internal distribution of all system level procedures will be as defined in paragraph 2.2.4, the responsibility of the subproject manager, spacecraft integration and test and in accordance with the configuration management plan. He in turn will delegate authority for the preparation; review, coordination, revision, distribution, and release to the procedure work package manager.

There are 79 test procedures and documents identified for use on ERTS. Of these, 73 are revisions of the existing OGO procedures and 6 are completely new.

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3. OBSERVATORY INTEGRATION AND FUNCTIONAL TEST

The subsystem integration and test activity begins upon the receipt of the spacecraft frame and the individual black boxes comprising the subsystems including the payload. This section outlines the mechanical and electrical tests for each subsystem, payload, telemetry calibration, system power profile, and a system compatibility test to verify noninterference or degradation among subsystems. The latter tests establish a baseline against which data obtained during systems testing is compared to evaluate system degradation.

Test procedures, conduct of the tests, and test results evaluation and documentation will be in accordance to test management criteria specified in Section 2.

Each major test herein is outlined as a task as it will be performed by TRW integration and test personnel.

3.1 MECHANICAL ASSEMBLY AND INSTALLATION

3.1.1 Structural Configuration Check

Task 1	Receive and visually inspect spacecraft structure
Purpose	To visually inspect the spacecraft structure for damage and to verify that black box hole pattern layout is to latest print configurations
Task 2	Mechanically inspect spacecraft structure
Purpose	Verify proper installation of all required hardware, that hardware conforms to the configured article list, and that all fasteners have integrity and are torqued to proper values.
Task 3	Deployment pneumatic system leak check
Purpose	To determine that the deployment tubing leak rate is within specifications.

3.1.2 Pneumatic Installation and Leak Test

Task 1	Install deployment, ΔV, and ACS pneumatics equipment
Purpose	To install all hardware and transducers for the deployment, ΔV, and ACS pneumatics equipment.

Task 2	ACS and ΔV pneumatic system leak check
Purpose	To determine the ERTS control system leak rate

3.1.3 Solar Array Shaft Installation

Task 1	Installation of the solar array shaft
Purpose	To mount the solar array shaft in the spacecraft structure
Task 2	Solar array proof-load test
Purpose	To ensure that structural safety margins will not be exceeded during solar array deployment in orbit
Task 3	Torque-theta tests
Purpose	To verify adequate net torque output throughout the deployment angle

3.1.4 Harness and J-Box Installation

Task 1	Install spacecraft harnesses and j-boxes
Purpose	Provide electrical interconnections between all subsystems

3.2 SUBSYSTEM INSTALLATION AND INTEGRATION

After each electronic assembly has completed unit level environmental and acceptance tests, it is delivered to the spacecraft assembly area. The electronic ground support equipment required for each subsystem is assembled and validated prior to use. Each subsystem is mechanically mounted to the spacecraft with appropriate connectors mated directly or through series fuse boxes. These fuse boxes allow examination and verification of all lines entering and leaving the assembly. Each black box and subsystem is integrated to published procedures delineating a step-by-step systematic approach. The following test sequence illustrates this approach in brief.

3.2.1 VHF Equipment

Task 1	Install and integrate the VHF command system
Purpose	To install and verify correct operation of the VHF command equipment which establishes an RF command link with the spacecraft

3.2.2 Data Handling Subsystem

Task 1	Install and integrate the data handling subsystem
Purpose	To mechanically install and integrate the data handling subsystem

3.2.3 Installation and Integration of the Unified S-Band Equipment

Task 1	Install and integrate the unified S-band equipment (USB) and the VHF transmitter
Purpose	To install and integrate the USB RF equipment and verify proper interface between units
Task 2	Functional test of narrow band equipment
Purpose	Verify operation of all units as a system in all modes
Task 3	Functional test USB equipment
Purpose	Verify proper operation and establish operating parameters of the USB equipment

3.2.4 Post Storage Torque-Theta Tests

Task 1	Perform post-storage torque-theta tests on the solar array shaft
Purpose	Verify that the effects of harness storage will not adversely affect deployment of the solar array system

3.2.5 Installation and Integration of the Power Subsystem

Task 1	Install and integrate the power control subsystem
Purpose	Verify proper operation of the PCU, thermal fins and test batteries

3.2.6 Installation and Integration of Attitude Control Subsystem (ACS)

Task 1	Install ACS equipment
Purpose	To assemble the ACS in the spacecraft as a subsystem
Task 2	ACS functional test
Purpose	Provide an end-to-end check to verify proper response of the ACS

3.2.7 Installation and Integration of Wide Band Video Equipment

Task 1	Install and integrate the wide band video equipment
Task 2	Functional check or WB video equipment
Purpose	Verify proper operation, establish operating parameters, and perform calibrations of the WB equipment

3.2.8 Prepayload Integration Spacecraft Compliance Test

A prepayload integration spacecraft compliance test will be performed prior to payload integration activities. This test verifies payload electrical and mechanical interface requirements.

Task 1	Verify that spacecraft/payload mounting provisions satisfy the payload mechanical interface requirements
Purpose	To ensure against payload damage due to potential misalignment
Task 2	Verify that all spacecraft/payload electrical interface requirements are satisfied
Purpose	To ensure that all spacecraft payload interconnecting wires are carrying the proper power, command and telemetry signals during spacecraft and payload operation; also verify that no adverse noise is present.

3.3 PAYLOAD INTEGRATION AND TEST

3.3.1 Introduction

Prior to observatory test and evaluation the payload equipment will be bench tested at TRW utilizing bench test equipment (BTE), supplied by the equipment contractor. The tests will be conducted in accordance with a detailed bench test procedure to verify systems performance. Applicable data from these tests will provide a performance baseline for subsequent spacecraft tests. After the bench tests are completed, the payload equipment will be mechanically installed in the spacecraft and optically aligned. Alignment tests will be performed on payload components requiring mutual alignment utilizing theodolite/ collimator techniques to ensure that the specified alignment requirements

are satisfied. Following the mechanical installation the payload equipment will be electrically integrated into the spacecraft. Power and noise tests will be conducted on each payload package to ensure electrical compatibility. Payload system tests will be performed by stimulating the sensors with an external source and monitoring end-to-end performance. A gross interference test will be performed to evaluate the functional interference to the payload by the spacecraft subsystems.

For each test required the payload equipment will be integrated in accordance with a detailed step-by-step written procedure with safeguards incorporated to protect each assembly from damage.

3.3.2 DCS Receiver and Antenna

Task 1	DCS receiver and antenna integration
Purpose	To mechanically mount the DCS receiver and antenna to the spacecraft structure and electrically integrate

3.3.3 Installation and Integration of RBV's

Task 1	Install and integrate the RBV's
Purpose	To install the Return Beam Vidicon cameras in the spacecraft compartment and to verify interface requirements are met

3.3.4 Installation and Integration of MSS and MUX

Task 1	Install the MSS and MUX
Purpose	To install and integrate the MSS and MUX in the spacecraft compartment and to verify that interface requirements are met

3.3.5 Installation and Integration of Video Tape Recorders (VTR's)

Task 1	Install and integrate video tape recorders
Purpose	To install and integrate the video tape recorders in the spacecraft compartment and to verify interface requirements

3.4 PAYLOAD/SYSTEM TEST

3.4.1 Telemetry Calibration and Power Profile

Task 1	Telemetry calibration
Purpose	To acquire data from which telemetry input/

output curves may be formulated for verification of system parameters

Task 2 — Power profile

Purpose — Determine efficiency of the power subsystem and drawn in all the different operational modes.

3.4.2 Payload and Spacecraft Compatibility

Task 1 — Perform spacecraft and payload compatibility test

Purpose — Demonstrate satisfactory operation of spacecraft communications, data handling, attitude control, power subsystem, and ERTS payload.

4. OBSERVATORY TEST AND EVALUATION

4.1 PRE-ENVIRONMENTAL SYSTEMS TESTS

4.1.1 Introduction

Prior to environmental testing of the ERTS spacecraft/payload system, a number of tests will be conducted to establish a baseline for comparison with data obtained subsequent to each environmental exposure. This is required to establish the magnitude of the effect of environmental exposure and verify nondegradation of the ERTS spacecraft system.

Selected data acquired during the integration and test sequence, Section 3, will be utilized as baseline data, i.e. power profile, telemetry calibrations, and RF subsystems data. These pre-environmental tests are as inclusive as practicable and include mass properties, pneumatics, control ordnance, the mechanical and electrical tests of spacecraft and payload.

The data derived during the integrated systems test becomes the functional criteria for detecting malfunctions and system degradation. Thus, the integrated systems test becomes the baseline reference for pre- and post-environmental testing and is conducted after each major environmental test and before shipment to the launch site. The tests outlined herein are described as a task as it will be performed by TRW integration and test personnel.

4.1.2 Pneumatics Proof and Leak Check

Task 1	Proof test and leak check the ACS pneumatics system
Purpose	(1) Verify system integrity to 1.5 times flight pressure and determine leak rate of system
	(2) Determine leak rate of system at flight pressure
	(3) Perform telemetry calibration of system pressure transducers

4.1.3 Integrated Systems Test Preps and Integrated Systems Test #1

Task 1	Integrated systems test preps
Purpose	Configure and verify all equipment ready for integrated system test
Task 2	Perform integrated systems test #1
Purpose	(1) To verify that all ERTS spacecraft subsystems and the ERTS payload are functioning properly while in as near flight configuration as possible. (2) To provide an end-to-end check of spacecraft and payload operation without interrupting normal inflight circuitry

4.1.4 Solar Array Compatibility

Task 1	Perform the solar array compatibility test
Purpose	To operate the complete power system in an end-to-end configuration by illuminating the arrays without the use of external power supplies

4.1.5 Weight and Center of Gravity Determination

Task 1	The weight and center of gravity in three axes of the observatory must be determined
Purpose	The measurement verifies the computation of weight distribution which affects ACS performance and response to dynamic stimulus.

4.1.6 Observatory Alignment and Field of View (FOV)

Task 1	Perform mechanical alignment of the horizon scanners, yaw gyro, attitude control nozzles, RBV camera assembly, and multispectral scanner to a common set of orthogonal axes. Accuracy requirements are as follows: (1) ACS components to each other - 0.1 degree, (2) RBV camera assembly to horizon scanners and yaw gyro - 0.1 degrees and (3) multispectral scanner to horizon scanners and yaw gyro - 0.1 degree.
Purpose	Alignment of ACS components is necessary to assure stability of control and minimization of use of attitude control gas.
Task 2	Perform sun scanner field of view test. Alignment of sensors is necessary to ensure pointing accuracy.
Purpose	Verify that no antennas or the array envelope are in the field of view of the earth scanners.

4.1.7 Previbration Test Preparations

Task 1	Prepare spacecraft for vibration testing
Purpose	To install remaining flight hardware and nonflight instrumentation in preparation for the sine vibration test
Task 2	Design engineering inspection
Purpose	To inspect the observatory for any damage or deficiencies
Task 3	Install solar array
Purpose	Complete assembly of spacecraft in preparation for vibration
Task 4	Complete ACS polarity tests and install on shaker
Purpose	Complete end-to-end polarity checks of the ACS system to verify correct installation of the gyros

4.1.8 Previbration Integrated Systems Test

Task 1	Perform previbration IST
Purpose	To verify that all observatory systems are functioning properly prior to vibration and establish previbration baseline Note: Results of this test will be compared with integrated systems test no. 1 data

4.1.9 Environmental Preparations

Task 1	Prepare for vibration test
Purpose	Complete all items to achieve all up condition for vibration test and final instrumentation preparation and calibration.

4.1.10 Sine Vibration

Task 1	Perform vibration
Purpose	Demonstrate that the observatory can survive simulated launch boost and injection environments

4.1.11 Post Vibration Integrated Systems Test

Task 1	Perform postvibration integrated systems test
Purpose	To verify acceptance level vibration has not degraded overall observatory performance.

4.1.12 Separation Band and Solar Array Release Test

Task 1	Perform separation band release test
Purpose	To subject the observatory to shock environment associated with observatory separation
Task 2	Perform solar array release test
Purpose	Demonstrate that the simulated boost and separation environments have not degraded the deployment system.

4.1.13 Acoustic Test

Task 1	Perform acoustic test
Purpose	Demonstrate the observatory can survive simulated launch boost and injection acoustical noise environments.

4.1.14 Post Acoustic Integrated Systems Test

Task 1	Perform postacoustic integrated systems test
Purpose	Verify acoustic exposure has not degraded observatory performance.

4.1.15 Solar Array Removal

Task 1	Remove solar array
Purpose	Facilitate alignments and prepare for thermal vacuum tests

4.1.16 Observatory Alignment Verification

Task 1	After vibration and acoustic testing, the relative alignment of the yaw gyro, horizon scanners, ACS nozzles, RBV camera assembly, and MSS must be remeasured.
Purpose	It must be demonstrated that dynamic environments do not affect the alignment of the critical components. The criteria for this verification is no shift from the initial position greater than five arc seconds.

4.1.17 Delta-V and ACS Leak Test

Task 1	Perform ΔV and ACS leak test
Purpose	To demonstrate that the simulated launch, boost, and injection environments did not degrade the integrity of the ΔV and ACS system.

4.1.18 Thermal Vacuum Preps

Task 1	Complete TV chamber preps
Purpose	Instrument the TV chamber to simulate ERTS TV and solar simulator requirements.

4.1.19 Prethermal Vacuum Integrated Systems Test

Task 1	Perform prethermal vacuum integrated systems test
Purpose	Verify TV set-up and establish baseline for post-TV evaluation.

4.1.20 Thermal Vacuum, and Solar Simulation

Task 1	Perform the solar array yoke release test
Purpose	Verify operation of the deployment system including ordnance under thermal and vacuum conditions.
Task 2	Perform thermal vacuum and solar simulation test
Purpose	Verify operation of the observatory in a simulated space environment.

4.1.21 Post Thermal Vacuum Integrated Systems Test

Task 1	Perform postthermal vacuum integrated systems test
Purpose	Demonstrate and verify that simulated space environment has not degraded the observatory performance.

4.1.22 Subsystem Test

Task 1	Perform subsystem test
Purpose	Establish a reference of important spacecraft parameters and augment data from the integrated systems test

4.1.23 Flight Battery Installation and Battery Capacity Test

Task 1	Flight battery installation
Purpose	To replace the test batteries with flight batteries
Task 2	Battery capacity test
Purpose	Determine the fully charged capacity of the flight batteries

4.1.24 Solar Array Installation

Task 1	Solar array installation
Purpose	Install solar paddles and sun sensors on the observatory in preparation for shipment

4.1.25 Payload Final Calibration

Task 1	Calibration and final checks of ERTS payload
Purpose	To conduct final payload calibrations and detailed preflight checks.

4.1.26 Detailed Engineering Inspection

Task 1	Perform detailed engineering inspection
Purpose	To check all internal systems and surfaces of the observatory to verify configuration prior to shipment

4.1.27 ACS and Delta V Leak Check

Task 1	Perform ACS and Delta V leak check
Purpose	Verify the environment has not degraded the pneumatic system

4.1.28 Final Sensor Alignment Checks

Task 1	Perform final sensor alignment checks
Purpose	To verify the alignment of all payload sensors has not degraded as a result of the thermal vacuum and solar simulation exposure

4.1.29 Spacecraft Installation on Interstage

Task 1	Install spacecraft on flight interstage
Purpose	Complete final preparations for shipment to WTR.

4.1.30 Practice Countdown

Task 1	Conduct the observatory portion of the WTR count-down procedure
Purpose	Wring out the countdown procedure and acquaint test crew with observatory unique systems procedures

4.1.31 Preship Integrated Systems Test

Task 1	Conduct the preship integrated systems test
Purpose	Verify all operations subsequent to the postthermal vacuum integrated systems test have not degraded observatory performance.

4.1.32 Final Door Torquing and Design Engineering Inspection

Task 1	Final door torquing
Purpose	To install permanent flight hardware and torque to specification requirements.
Task 2	Final design engineering inspection
Purpose	To check all external surfaces and hardware to verify launch readiness

4.1.33 All-Up Weight

Task 1	Perform determination of launch weight of ERTS observatory.
Purpose	Determine launch weight of observatory

5. DOCUMENTATION

5.1 INTRODUCTION

The first document prepared for the conduct and recording of the test program is the test specification usually issued at the same time as the equipment or design specification. The test specification provides such information as test objectives, test levels, test criteria, and criteria for retest.

Based on the test specification, a test procedure is written prescribing steps, sequences, and other details necessary for performing the test. This test procedure also contains a list of the values to be measured, including tolerances, and is used as a sheet on which to record actual measurements during the test. The formal record copy of all test procedures is maintained and filed by the quality assurance inspector. Parallel to recording test data, an observatory test log is maintained as a means of documenting the continuous observatory test history. A formal report for each test is prepared and issued.

In summary, prior to any test, test specifications and test procedures will be prepared. During testing, data will be recorded in test procedures, and events and history of items under test are recorded in log books. After test completion, test reports will be issued for any item tested.

5.2 TYPES OF DOCUMENTS

5.2.1 Classification

Documents are classified according to type as follows:

(a) Approval: Document requires approval of GSFC/PO.

(b) Review: Document subject to GSFC/PO review.

(c) Information: Document submitted for the purpose of determining current program status, progress, and future planning.

(d) Maintained: Documents readily available to GSFC/PO or its designated representative, but not to be removed from contractor's facility without specific consent of contractor.

5.2.2 Action Period for Documents

Approval and review documents are also classified according to the time in calendar days specified for GSFC/PO action. If not specified,

the action period on all documents or other activities requiring GSFC/PO approval or review is ten calendar days.

5.3 DOCUMENTATION REQUIREMENTS

5.3.1 Test Documentation

The following reports are required for conducting and recording the test program:

- Unit test reports: Required for all assemblies produced under the contract.
- Configured article lists
- System test reports: Comprehensive compilation of test results as well as any analysis required for interpretation of test results.
- Nonconformance reports: Description of nonconformance, analysis, corrective and preventive actions, and disposition of nonconforming article
- Failure summaries: Lists of all failures which occurred since the last failure review board meeting as well as items not closed out at the last meeting.
- Failure review board meeting minutes: Detailed reports of all actions at each meeting.
- Environmental test specifications: Specifications covering each test environment at the assembly, subsystem, and system levels
- Unit Data Packages: Accumulation of documents associated with the testing of each assembly under configuration control
- System and subsystem test data packages: Accumulation of documents for each test (including engineering and trouble-shooting tests) conducted with the spacecraft, starting with integration of the system.
- Equipment inspection and test procedures: Procedures for each inspection and test operation, except those which are an integral part of detailed fabrication documents
- Spacecraft log: Records of all activities associated with the spacecraft from initial integration to launch.
- Spacecraft model logs: Records maintained for all activities associated with the structural model spacecraft.

6. TEST RESOURCES

6.1 TEST FACILITIES AND EQUIPMENT

The diversified test capability of TRW will be used to support development and integration of the various subsystems used on the ERTS spacecraft. The particular facilities to be utilized for the ERTS test program are summarized in this section.

6.2 ENVIRONMENTAL TEST FACILITIES

The TRW environmental test laboratory is an integrated facility capable of subjecting spacecraft and their components to extreme conditions of temperature, humidity, vacuum, simulated solar radiation, mechanical shock, vibration, sustained acceleration, and acoustic noise.

6.2.1 Vibration

For ERTS the vibration exciter (model C-210) is enclosed in an acoustically insulated room, with remote control consoles to protect operating personnel from high intensity noise effects. The C-210 exciter is equipped with the necessary power supply and with controls permitting application of sine waves by manual, automatic, or tape command. Horizontal slip tables are provided for all exciters.

Since the interstage is identical, the vibration fixture fabricated for OGO can be used for ERTS with resultant economy and efficiency to the program.

6.2.2 Acoustics

Based on GSFC recommendations, an acoustic test in lieu of random vibration will be conducted on the ERTS system in the M-1 acoustic test facility.

6.2.3 Thermal/Vacuum Facilities

The facilities described below are available to perform space simulation tests on the ERTS observatory.

The chamber described here is a complete space-simulation facility which will simulate conditions of 1/2 to 2 "suns", vacuums in the 10^{-5}

torr range, and a space heat sink in the form of LN_2 cooled, $-300^{\circ}F$, high absorptivity shrouds. The shrouds may also be operated at temperatures of $-260^{\circ}F$ to $+275^{\circ}F$.

The chamber is a 22-foot diameter vertical cylinder with access by removal of the bottom closure. It will accommodate a 25-foot high test object 10 by 10 feet square with solar simulation and a 35-foot high test object 15 feet in diameter when not using the solar simulator.

6.2.4 TRW Alignment Facility

The alignment facility consists of the following equipment, with sensitivities, that is installed in the integration area of the observatory:

Rotary table - 15 arc seconds
Theodolite - 1 arc second
Optical micrometer - 0.001 inch

6.2.5 Leak Test Facility

The radiosotope method will be used to verify that the ERTS pneumatic subsystem leak rate is within the design and performance tolerance required.

6.2.6 Anechoic Chamber

The anechoic chamber, adjacent to Building M-2, will be used to support the ERTS-A observatory compatibility test.

6.3 SPECIAL FACILITIES

Those facilities which must be provided or configured as ERTS observatory unique are described in this section. Since these facilities are ERTS unique, they will be configured in a manner to be self-supporting and semi-independent to meet the ERTS launch schedules.

6.3.1 Integration and Test Facilities

An area of approximately 4206 square feet has been designated in building M-2 for this purpose and comprises five main work areas: ERTS assembly and test area, 1920 square feet; the control center, 460 square feet; computer center, 808 square feet; work and storage area, 280 square feet; QC and spacecraft crew room, 728 square feet.

6.3.1.1 Assembly and Test Area

The ERTS assembly and test area contains sufficient area to support ERTS spacecraft. The schedule calls for integration of ERTS-A and B in serial, but if necessary, the area is large enough to accommodate two spacecraft.

A continuous flow of filtered, conditioned air ensure spacecraft cleanliness and crew comfort. An overhead crane with hook capacity of 5000 pounds and floor clearance of 20 feet is used for spacecraft hoisting operations.

Electrical power requirements in this area are 115 vac, 60 Hz single phase outlets. Two circuits with 50 amp capability and 6 circuits with 30 amp capability are required.

Plant air outlets will be provided with a pressure gauge and filter at each termination point. A high pressure nitrogen system will terminate at a central point between the two spacecraft test bays. At this termination point, a control panel will be mounted to include the following:

- A one-micron filter
- Pressure regulator to reduce pressure and flow
- Two pressure gauges
  - High pressure gauge
  - Low pressure gauge
- Shut-off valve

From the high pressure nitrogen termination board to the spacecraft test bays two items are provided: two shut-off valves for each test bay, and a flow indicator for each test bay. Among the other items provided will be an overhead crane to be used for installation and removal of the spacecraft. A radioisotope tracer gas exhaust system with a 6-inch diameter exhaust duct will be provided.

6.3.1.2 Control Center

The control center, consists of the test conductor's console, a line printer, an analog recorder, and miscellaneous equipment. Visual access to the integration and test area and a door access to the computer center are provided. An access hole between the control center and

the computer center is also provided to allow passage of interconnecting signal lines to and from the line printer, intercommunications, and so on. Intercommunications are available to all other areas from the test conductor's console.

Electrical requirements of the control center equipment are 115 vac 60 Hz single phase outlets rated at 30 amps each. Approximately 5 tons of air conditioning are also required.

Since the test conductor has primary responsibility for all systems tests, all test operations and directives during tests will originate from this center.

6.3.1.3 Computer Center

The computer center will compile and process data and present to the test conductor a meaningful summary of real-time data from a given test while maintaining the capability to present for analysis all the data pertaining to any selected area. A door allowing access from the control center to the computer center will be provided.

The floor of the center is raised 10 inches to allow space for cable routing and airconditioning ducts which will supply air directly to the racks. Electrical power required for the computer ground station is 115 vac, 60 Hz single phase with a capacity of 40 kilowatts distributed to the racks.

6.3.1.4 Work and Storage Area

The work and storage area will be utilized for records storage, supplies and materials, and test equipment modification and repairs. Intercommunications will be provided as well as air conditioning.

Electrical power requirements are 115 vac, single phase outlets, rated at 30 amps each.

6.3.1.5 QC and Spacecraft Crew Room

This area will house QC and spacecraft crew personnel. Space for six to eight desks will be provided. The area will also be air conditioned and provided with intercommunications. Electrical power requirements are 115 vac, single phase outlets, rated at 30 amps each.

6.3.1.6 Interfacility Requirements

A network of cabling with patch panels located in the integration and test area, control center, and computer center will be provided to route the necessary spacecraft data and single lines for analysis and monitoring between these areas. Signal distribution amplifiers in the computer center will be utilized to minimize signal loss or degradation.

An intercommunication network with three channels will be connected between all test and integration areas as well as the spacecraft crew room. This network will also be connected to intercom facilities in the areas used for environmental testing.

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1. INTRODUCTION

The launch readiness review, launch site activation, and launch operations, are discussed ~~in this section~~. The launch operations plan as outlined in the phase B/C study proposal is essentially unchanged except for deletion of the prototype spacecraft tests and the addition of special S-band RF tests. Flight worthiness of the spacecraft is documented during the launch readiness review for government acceptance of the vehicle. Section 2 discusses in detail most of the AGE utilized in observatory testing. GSE particular to launch operations is discussed in the sections where it is utilized. With the exception of the S-band range checks both ERTS-A & B launch operations will be the same.

2. PRE-LAUNCH OPERATIONS

2.1 LAUNCH READINESS REVIEW

To assure launch readiness status and to facilitate Government acceptance of each ERTS observatory, a formal review will be documented and orally presented to NASA/GSFC subsequent to the successful completion of all acceptance testing and prior to shipment to Western Test Range (WTR). This review will include a performance assurance historical review and a current status of observatory configuration and malfunction disposition; a detailing of engineering analysis and test results; and a review and discussion of all problem areas which could have an effect on readiness status.

2.2 LAUNCH SITE ACTIVATION (PAD AND FACILITY VALIDATION)

The phase B/C proposal discusses site activation using a prototype spacecraft. Since the prototype spacecraft has been deleted, the facility validations will be accomplished in two parts time wise. The following paragraphs are detailed descriptions of these two time periods.

2.2.1 S-Band Range Checkout

Approximately 1 month prior to the beginning of launch operations, range compatibility checks for the ERTS S-band systems will be accomplished. A 10 x 10 ft plane reflector will be mounted on the RF antenna tower.

The reflector should be mounted high enough so there is line of sight to the 450 ft tower at South Vandenberg. The ERTS S-band simulator will then be set up on the fourth level of the gantry with the antenna pointing down-range. With the simulator transmitting in different configurations path loss checks will be accomplished at Building 840 through the 450 ft tower and the remote site.

A coordination meeting with WTR-ULO personnel will be held prior to testing to verify pad access and to outline the testing to be accomplished.

2.2.2 Pad and Facility Validations

Pad and facility validations starting on R-30 days and ending on R-20 days, verify the proper configuration and operation of all EGSE and

GFE facilities needed to checkout and launch the ERTS observatory prior to the arrival of the observatory at Western Test Range.

2.3 STADAN AND MSFN STATION COMPATIBILITY TESTS

As in the past with OGO, TRW will support GSFC in station compatibility tests. TRW expects to supply hardware and observatory data tapes to GSFC in sufficient quantity to check the following:

- VHF RF command and receive capability of the Stadan stations utilized on ERTS
- USB RF command and receive capability of the MSFN stations utilized on ERTS
- Wide S-band RF receive capability of the stations that are to receive the wideband payload data.

2.4 LAUNCH SITE OPERATIONS

The launch site operations as defined in the phase B/C are unchanged for the flight spacecraft. The basic operational concepts for ERTS launch operations are as follows:

- The ERTS launch plans are based on methods, test concepts, and technology developed and proven on OGO.
- The Western Test Range launch operations are conducted as an extension to in-plant testing and management structure using the same crews and specialists.
- Many of the pre- and post-environmental system tests are repeated on-stand to permit continued data correlation and performance verification.
- GSE, computers, and stimuli are the same as for in-plant testing to avoid test equipment uncertainties in evaluating satellite performance.
- Facility requirements are similar to OGO.

As on OGO the umbilical cables and spacecraft separation are the only major electrical interfaces to be verified. The observatory umbilical has been redesigned to accept the delta lanyard pull umbilical.

2.5 SHIPPING OPERATIONS

2.5.1 Preparation for Shipment

Task	The observatory all-up weight must be determined. All "red tag" items for transportation installed and documented, and the observatory installed on the flight interstage. The observatory must be installed in the transportation container and the container on the vertical transporter.
Purpose	Preparation for safe transportation to the launch site.

2.5.2 Observatory Shipment

Task	Transport the observatory to the launch site.
Purpose	To launch

2.5.3 On-Stand Operation

The OGO concept of launch operations is carried forward on ERTS; that is the observatory is delivered in launch configuration which requires no further tests prior to observatory mate.

2.5.4 Observatory Mate

Task	Remove the observatory from the transporter, hoist on stand, and mate with the launch vehicle.
Purpose	To mate to the launch vehicle

2.5.5 Compatibilities

Task	Observatory compatibilities
Purpose	(1) To satisfactorily demonstrate observatory/booster/launch pad interface operation (2) To satisfactorily demonstrate adequate RF transmission margins between the observatory and Building 840.

2.5.5.1 Integrated Systems Test

Task 1	Perform Integrated Systems Test preparations and on-stand Integrated Systems Test
Purpose	(1) To verify that all ERTS observatory subsystems and ERTS payload are functioning properly while in as near flight configuration as possible.

(2) To provide an end-to-end check of observatory and payload operation without interrupting normal inflight configuration.

Task 2 — Solar array field test

Purpose
(1) To verify there is no shorts or opens in the solar array paddle.

(2) To verify satisfactory operation of the array to spacecraft interface.

2.5.5.2 Mock Countdown Preparation

Task 1 — Perform mock countdown preparations

Purpose — To configure the observatory for mock countdown and install shroud

2.5.5.3 Mock Countdown

Task 1 — Perform a mock countdown

Purpose
(1) To train the launch crew

(2) To debug the countdown procedure

2.5.5.4 RFI

Task — Perform a combined radio frequency interference test.

Purpose
(1) To verify that no range radar interfers with observatory or booster operation

(2) To verify there is no observatory/booster interference

2.5.5.5 Final Integrated Systems Test

Task — Perform Integrated Systems Test preparations and final on-stand Integrated Systems Test

Purpose — To verify that all subsystems are performing properly before starting final launch preparations

2.5.5.6 Pneumatic Fill and Leak

Task 1 — Fill the pressure vessel to flight pressure and to leak check the pneumatic system.

Purpose
(1) To fill the pressure vessel to flight pressure in preparation for launch

(2) To verify that the pneumatic system leak rate is within the specified limit of 25 cc per hour

2.5.5.7 Launch Preparations

Task 1	Torque separation band
Purpose	To torque separation band to flight specification ensuring safe spacecraft separation.
Task 2	Battery capacity test
Purpose	(1) To erase the memory effect by reconditioning the batteries (2) To verify there has been no decrease in battery capacity
Task 3	Ordnance no voltage checks, ordnance installation, and red tag removal.
Purpose	(1) To verify there is no spurious voltage on the ordnance lines (2) To hook up ordnance in preparation for flight (3) To remove all red tags prior to launch
Task 4	Final design engineering inspection
Purpose	An engineering inspection by designated personnel from NASA, TRW, and payload contractors to verify there are no mechanical discrepancies on the exterior of the observatory.
Task 5	Install the observatory shroud
Purpose	To properly install the fairing halves and circumferential strap assemblies.
Task 6	Observatory GSE station validation
Purpose	To verify all the ERTS/EGSE is ready to support the launch

2.5.5.8 Countdown and Launch

Task 1	Perform countdown and launch
Purpose	To sequentially prepare the observatory and booster for launch.

2.5.6 Facility Requirements

SLC-2E or SLC-2W at VAFB with the existing NASA facilities at South Vandenberg will meet the requirements for launch of ERTS-A and B with no major modifications. Minor modifications are required in the following areas:

(a) Facilities in Building 840 - relocate or add electrical outlets.

(b) Addition and changing of antennas on the 450 foot tower at Building 840.

(c) Addition of a reflector at SLC-2E pad to reflect S-band R and F from the spacecraft to Building 840.

(d) Addition of an antenna tower with an S-band reflector if SLC-2W is used. A tower is already installed at SLC-25.

2.5.6.1 Hanger Floor Space and Communications

The same areas that were used for OGO are satisfactory for ERTS operations.

2.5.6.2 ERTS RF Station

Room A105 will serve as the RF station. Four more 120 vac 30 amp outlets will be needed. A patch panel will be installed to receive RF signals from the 450 foot tower and the ULO data acquisition site. The demodulated housekeeping data will be routed to the computer center for data processing. The received wideband S-band will be routed to the payload GFE located with the RF station.

ERTS Control Center

The control center layout will be identical to OGO except that the control center console will be only three bays instead of five.

ERTS Assembly Area

The hi-bay assembly area will be utilized to store the observatory and transporter between the time the observatory arrives from Space Park until it goes to the pad. The mechanical handling GSE will also be stored in the assembly area.

RF Data Acquisition

With the ERTS RF station located in Building 840, the 450 foot antenna tower in conjunction with the ULO remote site will be utilized to receive and transmit all RF links to and from the observatory.

2.5.6.3 Launch Complex Space and Communications

The existing facilities on SLC-2W provide the necessary electrical interface between the launch complex, Delta, and the spacecraft to meet ERTS requirements with one minor exception. The Delta umbilical does not contain coax-cables for spacecraft baseband signal output; however, ERTS requirements can be met operating at 1 Kbs by a twisted shielded pair, which are available, and an access port located in the fairing. The USB baseband will be taken directly from the spacecraft test connector to the baseband amplifier without going through the Delta umbilical. At times when the shroud is on, the cable will be connected through the access port. The only restriction this produces is during countdown after gantry removal, USB baseband, or 32 Kbs data cannot be received via hardline. This is not considered a problem.

The existing microwave system is capable of transmitting baseband data from the launch pad area to the hanger. It is capable of transmitting both the VHF subsystem baseband and the USB baseband composite baseband simultaneously.

2.5.6.4 Electrical Power Requirements

Standard operating and emergency electrical ground power supplies are required for launch operations as follows:

- Launch Pad Building for battery charger (Rack D)

  115 VAC, 60 cps, 1 phase, 1 outlet, 50 amps

- Blockhouse for Launch Console (Rack A, including battery charge control)

  115 VAC, 60 cps, 1 phase, 1 outlet, 30 amps

- Launch Stand (4th level) (Rack B and DCS stimulus unit)

  115 VAC, 60 cps, 1 phase, 4 outlets, 30 amps each

- Launch Stand (5th level)

    115 VAC, 60 cps, 1 phase, 2 outlets, 30 amps each

- Data Center (Building 840)

    115 VAC, 60 cps, 40 Kw total to data center distribution circuits

- Control Center (Building 840)

    115 VAC, 60 cps, 1 phase, 3 outlets, 30 amps each

- RF station (Building 840)

    115 VAC, 60 cps, 1 phase, 6 outlets, 30 amps each

Supplies

Gas Required

Nitrogen gas per MIL-N-6011 and from (PCA) is required for drying and flushing pneumatic tubing on the gantry. The gas is to be furnished by the range. Test argon gas in 1.5 cubic foot bottles at approximately 2300 psi (12 bottles) will be supplied by TRW and be analyzed to assure that 1/100 percent allowable impurity limit is not exceeded.

The GFE krypton gas is received at TRW in standard 6000 psi ICC 3AA bottles pressurized at 4500 psi. Two bottles are received for each launch. Analysis is made for impurities and a dew point check is accomplished. At this time the krypton 85 radioactive tracer is added to the gas. The bottles are then shipped to Western Test Range and moved to the gantry fourth level for filling the spacecraft bottle.

Shop air at 100 psi with sufficient flow rate and capacity is required to operate pneumatic tools at Building 840 and the gantry.

EARTH RESOURCES TECHNOLOGY SATELLITE

FINAL REPORT

Volume 12. Integration and Test Plan

April 17, 1970

prepared for

National Aeronautics and Space Administration
Goddard Space Flight Center

Contract NAS5-11260
item 5a

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ROAD MAP

REVISIONS AND ADDITIONS TO FEBRUARY SUBMITTAL

A summary of the GDHS integration and test plan has been prepared for inclusion in Volume 12 of the final report. The enclosed material should be bound in at the back of the volume. Because the volume now encompasses all elements of ERTS, its title is changed to Integration and Test Plan so that it does not refer only to the observatory.

CONTENTS

OBSERVATORY INTEGRATION AND TEST PLAN

LAUNCH OPERATIONS PLAN

CONTENTS (Continued)

GROUND DATA HANDLING SYSTEM

1. INTRODUCTION

This part of Volume 12 summarizes the GDHS integration and test plan, including test management, and outlines the integration and test plan for the OCC, the NDPF, and the complete GDHS. Items included are:

- OCC subsystem level tests at the TRW factory and at NASA GSFC
- NDPF subsystem level tests at the IBM factory and at GSFC
- GDHS system level tests including compatibility testing between the OCC and remote stations and between the OCC and NDPF
- Post-launch demonstration.

Also presented is a summary of test management, special test equipment, and facilities planned for implementation of the test program.

1.1 GENERAL DESCRIPTION AND FLOW DIAGRAM

1.1.1 Introduction

The OCC and NDPF are each integrated independently in their respective factories and are each shipped to GSFC for installation, integration, and test. They are then tested for mutual compatibility and for compatibility with the remote NASA stations. It should be emphasized that the total integration of the OCC and NDPF is the responsibility of the TRW integration and test subproject manager who must oversee both efforts in order to assure on-time completion. Figure 1-1 depicts the overall test flow.

1.1.2 Factory Assembly, Integration, and Test

The OCC consists of TRW-manufactured, purchased, and subcontracted hardware and government furnished hardware integrated into a complete system. Drawers, racks, cabling, and subsystems are integrated in the OCC test and integration facility located in Building 74 at TRW's Redondo Beach, California facility. Simultaneously, the computer software is developed and tested. Compatibility of the hardware and software is accomplished in Building 74 by a test team and support personnel from the hardware and software areas. Subsystem level testing precedes shipment of the OCC to GSFC.

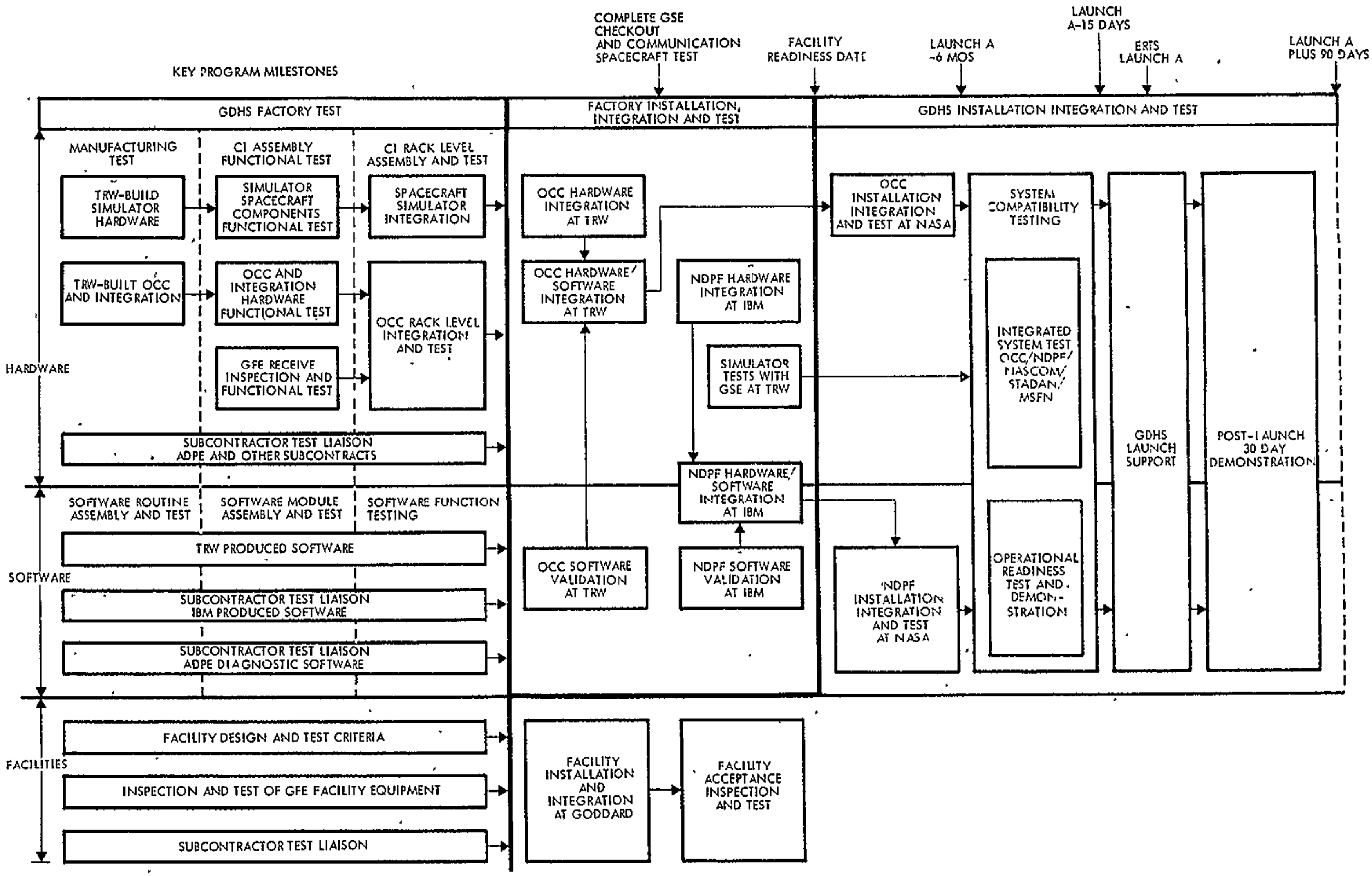

Figure 1-1. GDHS Test Flow Diagram

The NDPF is a combination of IBM and Itek hardware consisting of manufactured, purchased, and subcontracted items and government furnished hardware. The basic operating system is integrated and tested at the IBM facility in Gaithersburg, Maryland using in-house computers. Hardware, software, and hardware-software testing are included in the factory plans. Prior to shipment to GSFC, the NDPF is tested in a configuration which will not include the ADPE, precision photographic restitutor, photographic equipment, and OCC interface.

1.1.3 Installation, Integration, and Test at GSFC

Upon receipt of OCC and NDPF equipment items from their respective factories, each is installed, checked out to verify that the shipping and handling caused no adverse effects, and tested with the equipment that was not available during the earlier factory testing. The OCC and NDPF are individually tested in complete configurations.

The next phase of testing involves compatibility testing of the OCC with each of the remote stations, and of the OCC with the NDPF. Upon completion of these system compatibility tests, the hardware/software system is complete. The next phase is operations readiness which culminates in launch and the post-launch 30-day demonstration which constitutes NASA final acceptance.

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2. SYSTEM TEST MANAGEMENT

This section describes the management procedures for directing and controlling the integration and test program.

2.1 ORGANIZATIONAL RESPONSIBILITIES

The ERTS project office provides overall direction and review of GDHS test planning, test operations, and test reporting through an assigned test director. Direct management relative to the planning, conduct, and and approval of test operations is furnished through a test manager (subproject manager for integration and test). The test manager is responsible for both the NDPF and OCC as well as the overall GDHS integration and test tasks. The project office manager of systems engineering is responsible for the overall review of the test program to ensure that all performance requirements and mission objectives are satisfied.

The next level or organizational responsibility within TRW for the OCC lies with the managers of the hardware and software subsystems, who serve as test managers within their areas of responsibility. They are responsible for planning and executing their respective test programs with the concurrence of the integration and test subproject manager and prior to delivery to the systems integration and test area. They are responsible for obtaining the necessary resources from their own management.

Assigned test personnel are responsible for detailed test planning and procedures, planning of test equipment and facilities requirements, and the conduct and reporting of the test.

The quality assurance organization is responsible for providing qualified test surveillance personnel. Quality assurance representatives participate on the test review board. The reliability organization provides for a review and analysis of failure reports and participating on various test review boards. For the NDPF, the test manager will assign a representative to reside at the IBM facility during the integration and test phase. This representative will also monitor the test program at the Itek facility and will monitor NDPF testing at GSFC.

2.1.1 Test Planning and Operations

The initial task required is the preparation of the overall GDHS integration and test plan, which is subdivided into three areas: OCC, NDPF, and GDHS. This plan provides a sequence of tests, test descriptions and purposes, and test schedules.

This plan is reviewed by the test manager and test director and forwarded to GSFC for approval. In the interim, as test requirements become more specific, more detailed plans are prepared. After receiving GSFC comments, the plan is updated and resubmitted. Subsequent to this, no additional revisions or schedule changes are made to the integration and test plan itself.

The next step is generation and review of detailed test procedures, initiation of test resource planning, and final test preparations. Upon test procedure approval, tests are initiated.

Throughout the test operations, the test conductor and the quality assurance representative are responsible for maintaining the required documentation. The test director maintains daily contact with the test manager for direction and assistance.

Formal tests are normally performed only on equipment configurations that contain accepted hardware and software. However, when such hardware or software are unavilable, the test conductor may proceed after notifying the subproject manager, test director, and assigned quality inspector. The test director in turn notifies NASA. Whether such tests must be repeated with accepted hardware is determined by a test review board.

2.1.2 Test Review

A test review board reviews all test results. These tests begin with hardware testing at the factory and conclude with the completion of testing at the GDHS level two months prior to launch. The board members are:

TRW Representatives

- Test manager
- Test conductor
- Quality assurance inspector
- System and unit engineers as required

Goddard Space Flight Center Representatives

GSFC representative (systems level test only)

For test review at the IBM and Itek facilities, the TRW representative is a member of the board consisting of either IBM or Itek personnel. The board reviews the test data in light of acceptance/rejection criteria and decides whether to proceed to the next test. If a test is rejected, retest requirements are defined and the test or portion of test rerun; if not, the test configuration is broken down and preparations for the next test are begun.

A failure is defined as a deterioration or change in performance of any test article that prevents it from meeting functional, operational, or design requirements throughout its specified life. If a failure occurs, the test sequence is discontinued until the failure (including design or fabrication defect) has been corrected. After correction, the test procedure is repeated in its entirety unless otherwise specified by the test conductor. Every malfunction or failure is noted and reported in accordance with the formal failure reporting system.

At the completion of a test, a test data package is prepared and the test review board convened to verify adequacy of the test.

2.1.3 Test Data Package

The test conductor, assisted by the quality inspector witnessing the test, is responsible for the assembly of a test data package immediately after completion of each formal test operation. The data package includes the record copy of the executed test procedure, the record copy of an executed procedure for any repeat test, a copy of each applicable test change record and/or test record sheet, strip chart records, printouts, etc. All data sheets, recordings, printouts, etc., which are supplementary to but not part of the official test data package, are assembled and filed by the test conductor as part of the equipment log.

2.1.4 Test Personnel Responsibilities

2.1.4.1 Test Director

The project office manager for GDHS installation, integration, and test is responsible for the overall test program. He is responsible for

coordinating with the equivalent GSFC test director to review and approve the test plan. The test director or his designated alternate acts as a member of the test review board.

2.1.4.2 Test Manager

The test manager (the subproject manager of integration and test) is responsible for the generation and implementation of a complete OCC, NDPF, and GDHS system test program. His duties include coordination of test planning and scheduling, coordination and approval of test procedures, and serving as chairman of the test review board. As chairman he coordinates meeting schedules and presents the test data package at the meetings.

2.1.4.3 Test Conductor

The test conductor is responsible for the detailed planning and conduct of all test operations, development of an efficient test sequence, preparation of test procedures, ensuring the validation of test equipment, and obtaining final approval from the test review board. The test conductor directs the test crew and is assisted by design engineers as required. He is responsible for assembling the test data package after completion of a formal test.

2.2 TEST PROCEDURES

A number of test procedures are required throughout the OCC, NDPF, and GDHS integration and test program. Hardware items subcontracted by TRW require test procedures prepared by the manufacturer and approved by TRW. These procedures are run at the manufacturer's plant, again at TRW's integration and test facility, and possibly a third time at GSFC. Subsystem testing requires procedures. These tests involve various combinations of previously tested subsystems, hardware, and OCC cabling for loop testing. For testing at GSFC a number of these subsystem loop procedures (with some variations) are reused. In addition, several new procedures are required.

Test procedures are generated by IBM for NDPF configurations. These procedures are reviewed by the test manager's representative at the IBM plant.

The compatibility testing which follows OCC integration and subsystem testing at GSFC also involves the creation of several procedures which must be approved by NASA.

2.3 QUALITY ASSURANCE

Quality assurance requirements for the GDHS are outlined in the ERTS quality program plan which is in compliance with NASA document NHB-5300.4(1B). The document specifying performance assurance requirements for the procurement of GDHS equipment is PAR 700-55, structured in accordance with NPC 200-3, with amendments for GDHS hardware. To assure that the subcontracted equipment procured for the OCC and NDPF conforms with prescribed requirements, TRW performs source surveillance for inprocess inspection and final acceptance of the procured items. The performance assurance documentation that must be submitted by the supplier, concurrent with delivery of the completed assemblies, is listed in PAR 700-55.

TRW-fabricated equipment for the GDHS is controlled by standard quality assurance procedures. However, the level of inspection participation during buildup of the ground equipment is decreased for economical advantages and is described in functional detail in Table 2-2 of the "ERTS Quality Program Plan." Quality engineering and inspection support of OCC compatibility and integration test operations at TRW and at GSFC is provided to assure compliance with specified requirements.

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3. GDHS INTEGRATION AND TEST

3.1 OCC INTEGRATION AND TEST

OCC integration and test includes four separate categories as shown in Figure 3-1. Two categories are performed at TRW in Redondo Beach, California and the other two at GSFC. This arrangement was designed to meet the objectives of integration and test with respect to GDHS integration and test, tracking, launch, site availability, and hardware delivery. For a more detailed discussion of OCC integration and test, see Volume 25 of the TRW proposal.

The hardware tests, described below, are basically tests designed to insure proper equipment performance following delivery to the TRW OCC integration and test site at Building 74. These tests are:

- PCM equipment. A test, designed by the subcontractor, to exercise all normal modes of operation but without the aid of a computer.
- DCS equipment. A test on the DCS rack, made by TRW, to show proper performance of the DCS drawers without connecting to other OCC equipment.
- Tape recorder. A receiving inspection test to show proper operation of each recorder.
- Stripchart recorder. Same as tape recorder.
- Data distribution rack. A test on a TRW-built rack containing a mix of TRW-built and purchased drawers. Each separate drawer is tested to ensure proper functioning.
- ADPE. This test is a rerun of the vendor factory acceptance test, using special test software or test equipment to show proper operation prior to integration in Building 74.
- Display equipment. A test on the hardware to insure proper performance prior to inspection. This is also performed by the subcontractor using his equipment and procedures.

Following these hardware tests, integration tests are made at TRW. These tests incorporate various combinations of equipment, test software, and OCC cabling and consist of:

- Display subsystem integration test. In this test, the display, ADPE, and cabling are integrated into a complete subsystem to demonstrate proper operation.

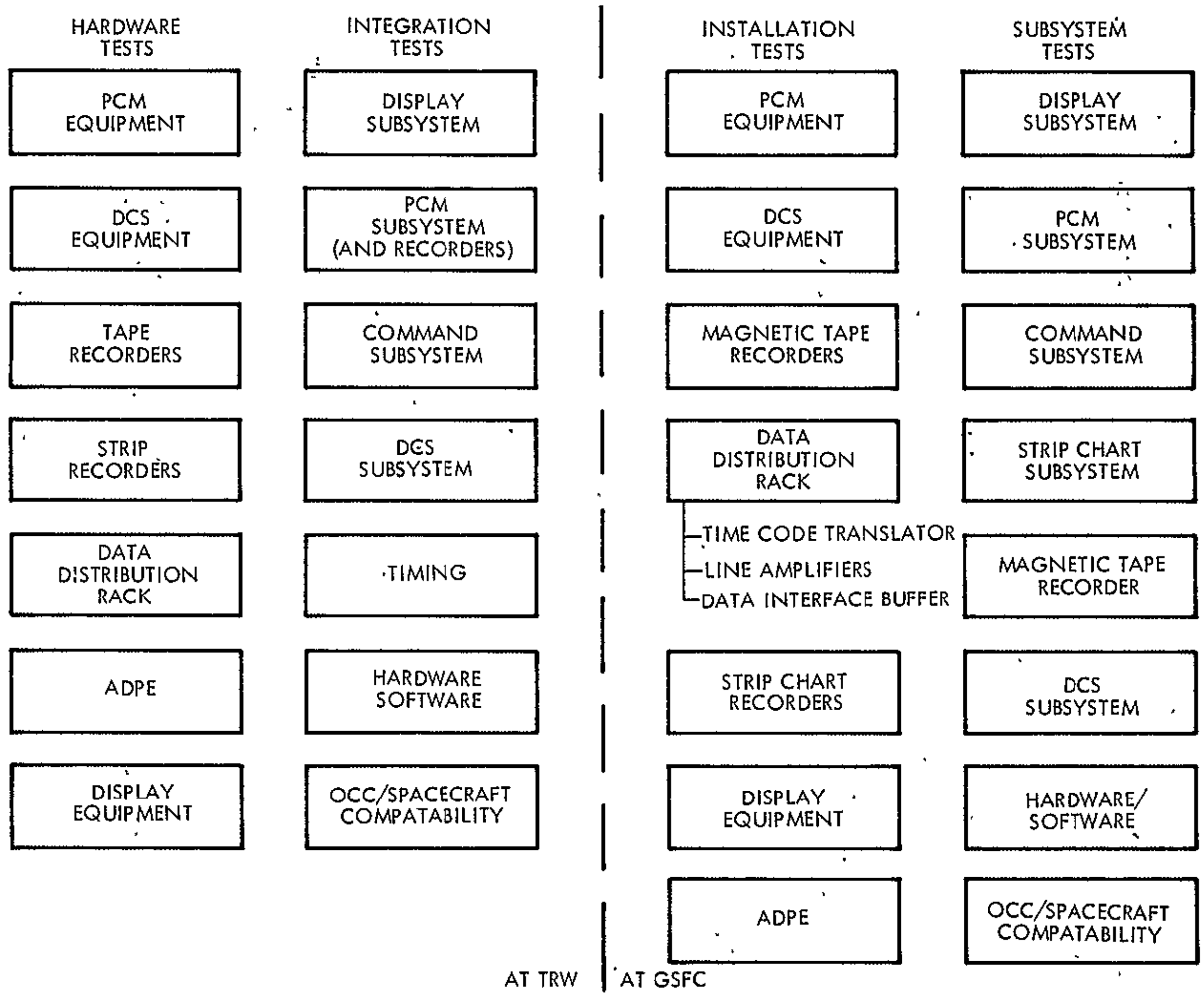

Figure 3-1. OCC Integration and Test

- PCM subsystem. In the PCM subsystem test, the display and ADPE are connected with the decom and its input switching to form a complete telemetry input processing and display subsystem. The test demonstrates complete subsystem operation.

- Command subsystem. This test uses the ADPE, display and data interface buffer (DIB). Commands are generated, displayed, and loop tested performed to show proper operation.

- DCS subsystem. The DCS subsystem includes equipment in the DCS racks, decom, ADPE, plus input equipment. The test utilizes a simulated input signal to produce a tape output. Playback of the output tape demonstrates the subsystem operation.

- Timing. This test is continuous once the equipment is connected. The timing system will not be shut down until shipment.

- Hardware/software. The integration of operational hardware and software utilizes the software directly associated with the hardware functions. Certain of the prior tests will be repeated for this demonstration.

- OCC/Spacecraft compatibility. This test consists of sending commands to the spacecraft via the spacecraft EAGE and observing the telemetry for proper indication in the OCC. The spacecraft could be placed in TRW Building M1 and the connection made via data modem and telephone circuits.

Subsequent to these tests, a conditional final inspection and acceptance is made by GSFC. The OCC is then dismantled, packaged for shipment, and shipped to GSFC via GFE bill of lading. The equipment is unloaded and installed in GSFC Building 23 and the following installation and subsystem tests performed:

- Installation tests. These are a vertical duplication of the factory hardware tests, and made for the same reasons, i.e., to ensure that the equipment arrived intact and undamaged.
- Subsystem tests. These are similar to the factory tests. Each major subsystem is tested using, wherever possible, the same techniques and procedures used previously at the factory.

A staging area, discussed in Part I, Volume 2, Section 5 of the proposal may be used for receiving inspection and storage if the GSFC Building 23 facility is not ready for occupancy on receipt of equipment.

3.2 NDPF INTEGRATION AND TEST

This section presents the approach to the installation, integration, and test of the NDPF system. For a more detailed discussion of NDPF integration and test, see Volume 30 of the TRW Proposal.

The NDPF system (Figure 3-2) must be integrated in an orderly and logical sequence in order to assure interface compatibility and performance. Hardware and software integration, and ultimately system integration, test, and evaluation must be performed,

IBM supports TRW in performing the NDPF integration and test. The non-ADPE equipment for the NDPF is delivered to the IBM plant in Gaithersburg, Maryland, where IBM supports the factory build-up of the NDPF using in-house computers. The factory configuration does not include the ADPE, precision photographic restitutor, or photographic processing equipment.

The buildup of NDPF hardware and software (Figure 3-3) is accompanied by appropriate testing as various configurations are attained. Each unit purchased by IBM undergoes unit acceptance test at the vendor location prior to shipment to IBM Gaithersburg. Upon receipt at IBM, each undergoes a receiving inspection to assure that no shipping damage has occurred.

At IBM, the IBM-make units, after static testing, are combined with the applicable purchased and GFE units into subsystems. Subsystem testing takes place using a computer interface which simulates the ADPE by using diagnostic software. Simultaneously, operational software testing on an IBM in-house computer takes place. Upon completion of operational software testing and hardware subsystem testing, the hardware-software integration commences using an IBM in-house computer. Upon completion of this phase, the equipment is shipped to GSFC where it is installed. At this time the ADPE for the NDPF will have been installed and checked out at GSFC. The initial hardware checkout using the ADPE uses diagnostic software. This hardware checkout includes the Itek supplied hardware, which was checked out by Itek previously at their plant. This hardware checkout provides for conditional acceptance testing of IBM make units. Operational software is checked out in the ADPE.

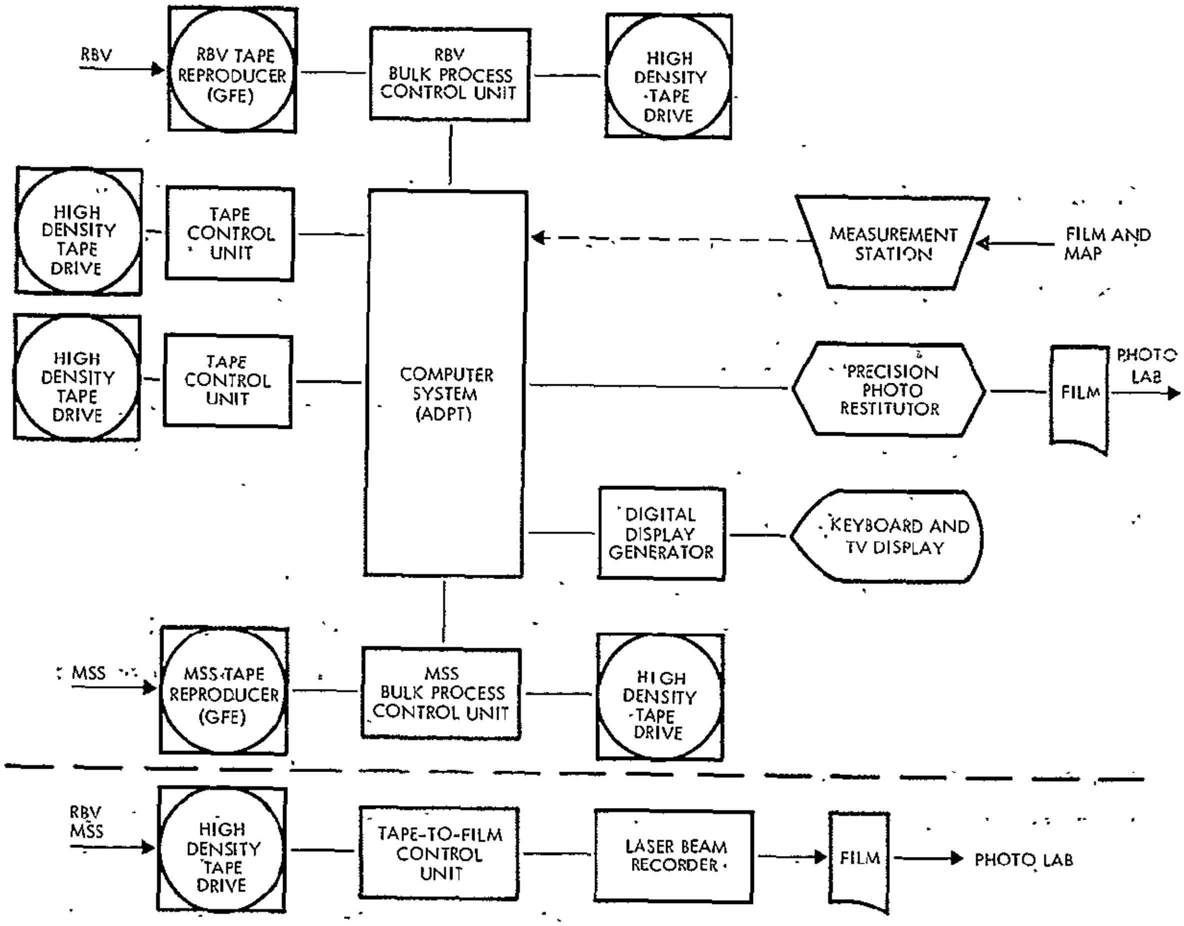

Figure 3-2. NDPF Block Diagram

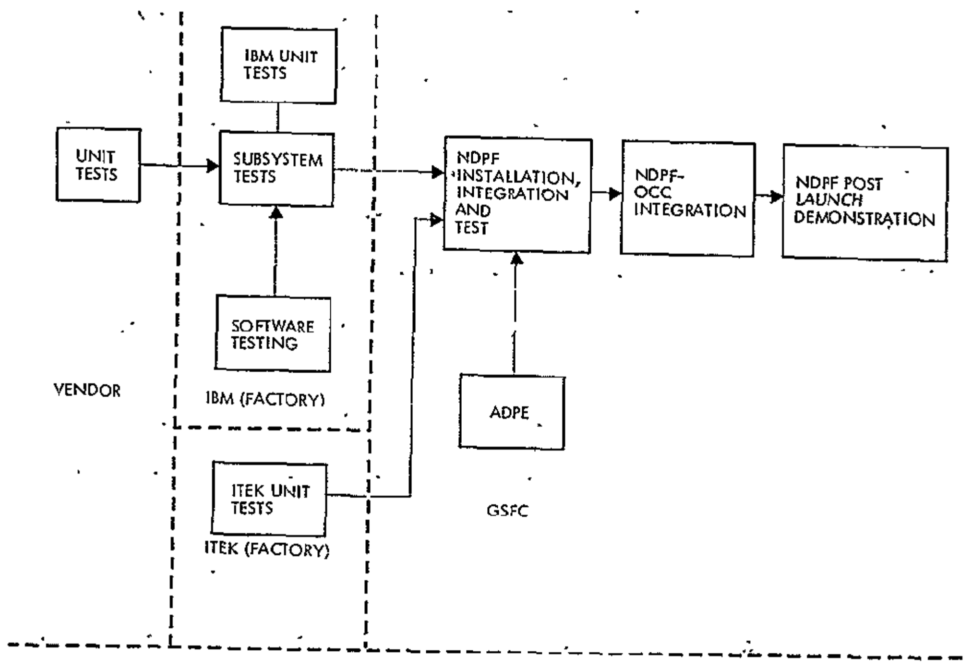

Figure 3-3. NDPF Installation, Integration, and Test Flow

The next phase of test is the hardware-software integration which ties the hardware to the operational software using the ADPE for the first time. Completion of this phase results in NDPF conditional acceptance. The NDPF is then used for NDPF-OCC integration launch support and post launch demonstration phases.

3.2.1 Integration and Test

This section describes the planned integration and test sequences for the NDPF (Figure 3-4).

3.2.1.1 Hardware Integration (Factory)

The units purchased by IBM undergo unit tests at the vendor plants based on approved vendor test procedures. The tests are monitored at the vendor plants by appropriate IBM and TRW engineering and quality assurance personnel. Each vendor is responsible for any special test equipment required and the actual performance of each test. Upon successful completion of the unit acceptance tests, the vendor units are packaged and shipped to the IBM factory in Gaithersburg, Maryland. Upon arrival at IBM, a receiving inspection test verifies that no damage has occurred due to shipping and handling. Government furnished equipment undergoes a receiving inspection test at the IBM factory.

Special test equipment will not be designed by IBM to unit test the IBM fabricated units. These units will be interfaced with the other subsystem hardware and tests run with diagnostic software in an IBM in-house computer (IBM 360-40) to demonstrate that each unit functions in accordance with its hardware design specification.

The precision photographic restitutor is integrated at the Itek factory with a computer interface. The unit has its data interface verified and is operated in open and closed loop modes to generate control photographs and restituted output photographs. The unit is packaged and shipped directly to GSFC.

3.2.1.2 Software Integration (Factory)

The integration and test of operational software proceeds in a manner similar to hardware integration. The integration begins with module testing of subprograms followed by functional testing and ending

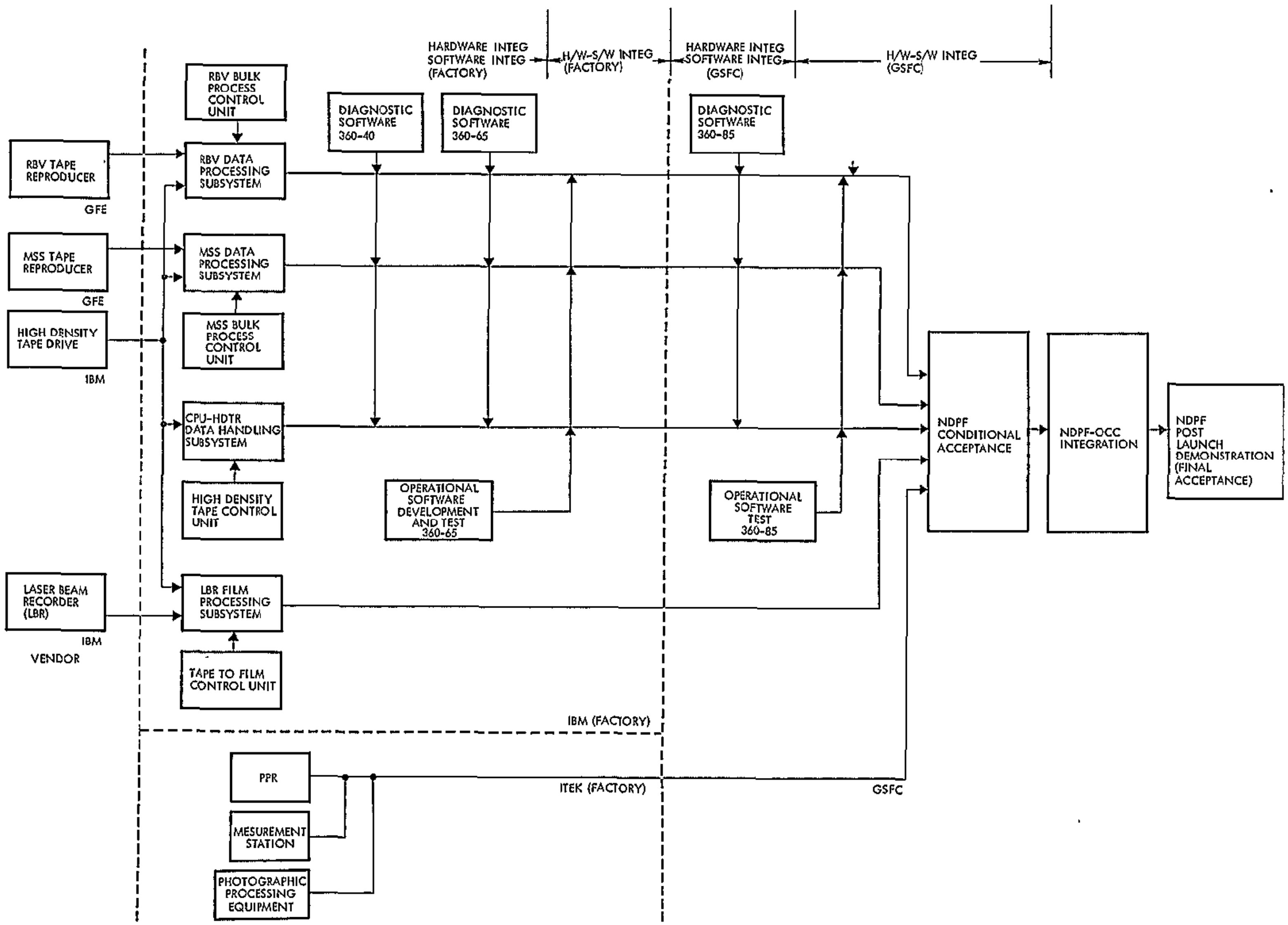

Figure 3-4. NDPF Integration and Test Sequence

with total software system test. An in-house computer (IBM 360-65) is used for software test. The major steps are:

- Program module test design. A definition of the tests required to ensure that the program module performs its functions and/or calculations as determined by a knowledge of the module design and specifications.

- Module tests. The program module is tested open loop using static input parameters over a range of expected values. Test drivers or special test routines are developed to aid in the test implementation and evaluation of results.

- Functional integration. Program modules are assembled into a function package.

- Function test. The assembled function is tested as a package to ensure that program modules interface properly and that specified data processing and computational requirements are met.

- Software integration. When a major function is tested as an entity it is integrated with the operating system and other application programs to assure that it meets specifications while operating as a total software system, and does not cause deterioration or conflict with other functions or with the operating system.

It is possible that the operational software may be used in a computer similar to the operational ADPE (IBM 360-85) at some time during software integration. Lack of firm information as to computer availability at this time forces test planning to regard this as a possible and desirable option.

3.2.1.3 Hardware/Software Integration and Test (Factory)

Following hardware and software integration, the system must be tested as a total system except for the ADPE and precision photographic restitutor, which are not available until the system is relocated to GSFC. During these tests, the NDPF system performance requirements and objectives are verified to the greatest extent possible. During hardware/software integration, operational hardware and software are used to the maximum degree possible. The IBM in-house computer 360-65 is used during these tests. Since both the hardware and software have been previously interfaced with the 360-65 computer, the purpose of these tests is to verify compatibility between the operational hardware and software using the 360-65 as the data processing vehicle.

The hardware configuration will be less the precision photographic restitutor, photographic equipment, and OCC interface. This configuration, coupled with the fact that the operational computer is not being used, necessitates the use of either simulation hardware, test software, or both to provide for meaningful testing.

These tests constitute the last series to be performed at the factory. They are scheduled so that their conclusion coincides with the availability of the NDPF ADPE at GSFC.

3.2.1.4 Shipment to and Installation in GSFC

Upon successful completion of the hardware-software integration test in the factory, the NDPF equipment is dismantled, packaged, and shipped to the NASA facility. Upon arrival, the equipment is installed in Building 23 in accordance with the approved facility planning documents.

A staging area, discussed in Part I, Volume 2, Section 5 may be used for receiving inspection and storage if the GSFC Building 23 facility is not ready for occupancy on receipt of equipment.

3.2.1.5 Hardware Test (GSFC)

The first phase of testing at GSFC involves the checkout of the newly installed hardware to verify that no damage has occurred due to shipping and handling and also that cable connections have been properly made.

Those units that provide for their own self check are tested in their self test mode after it has been verified that the facility power requirements are proper prior to connection. Each subsystem is then connected and, with diagnostic software routines in the ADPE, a test of each subsystem is made, similar to that previously accomplished during factory hardware integration and test. This is the first time that the operational ADPE is interfaced with the hardware. These configurations also serve as a basis for performing formal unit acceptance tests on the IBM-manufactured RBV bulk process control unit, MSS bulk process control unit, and high density tape control unit.

These tests consist of electrical performance checks, with maximum use of diagnostic routines to demonstrate that each unit functions in accordance with its hardware design specification. In addition, the units are tested to verify timing, signal levels, waveshapes, operation under bias,

etc. The reason for waiting until this point in the test program to perform formal unit tests is that the computer interface is, for the first time, the actual one to be used operationally. Therefore, we can realistically exercise the interface in this configuration, in lieu of building special test equipment. The in-house computer previously used at the factory is not the operational interface and thus was not considered for use during formal unit acceptance test.

The PPR is also interfaced with the ADPE for the first time during this phase. Itek essentially reruns the PPR acceptance test previously performed in the Itek factory, using the ADPE interface and diagnostic software.

Itek personnel support the installation and test of all photographic laboratory equipment.

When performing subsystem checkout, functions such as subsystem interference, power grounding, and RFI are examined.

3.2.1.6 Software Test (GSFC)

Operational and diagnostic software will be using the NDPF ADPE for the first time. There is a possibility that some of the operational software will have been checked out on a computer similar to the operational version during factory software integration, but that is only an option at this time.

The operating system and applications programs are checked out separately and with each other to assure operation as a total software system. Tests are performed to verify that, when programs are operated at the same time, there is no deterioration or conflict with applications or operating system programs.

3.2.1.7 Hardware/Software Integration (GSFC)

Following hardware and software integration, the system must be tested as a total system. During these tests the NDPF system performance requirements and objectives are verified. During hardware/software integration, operational hardware and software are used exclusively. Since system performance objectives are being verified, it is necessary to input characteristic data into the NDPF such that expected input conditions are simulated both in terms of the data content

and the expected data rates. These inputs include:

- Predicted ephemeris tape
- Telemetry data tape
- Computed ephemeris tape
- Bulk RBV tape
- Maps
- Bulk MSS tape
- DCS preprocessed data tape
- User abstract forms.

These inputs result in the following system products, which can then be evaluated for quality, throughput, and performance:

- Digitized image data tapes
- Bulk mode images
- Montage catalog
- Precision processed images
- Archival tapes
- Data base files
- Spacecraft performance and sensor health tapes
- PCM master digital data tape
- DCS file listings and tapes
- Index/abstract file, listing, tape and catalogs.

This culmination of this hardware/software integration test is the performance of an NDPF conditional acceptance test in accordance with the approved test procedure.

3.3 GDHS INTEGRATION AND TEST

Upon completion of the tests previously described which check out the OCC and NDPF as entities, the GDHS integration and test phase of the overall testing sequence begins. Figure 3-5 depicts the tests required. The tests performed in this phase are basically compatibility tests. This group of tests is new and the purpose is to demonstrate compatibility of the OCC and NDPF with their working interfaces. NASA remote stations are used to provide a complete ERTS operational system. These tests consist of:

- <u>Interface</u>. The OCC interfaces with NASCON, NTTF, and NDPF are used. Each is separately checked, permitting the next test to proceed.

- Remote station. Each prime remote station is operated with the OCC to demonstrate command, data, and voice compatibility.

- Simulator testing. The simulator is used at each prime station and operations conducted with the OCC. The test demonstrates overall compatibility of the OCC and remote stations with the spacecraft. If necessary, a fly-by test can also be performed.

The completion of the aforementioned compatibility testing sets the stage for the operational readiness phase prior to launch. Subsequent to spacecraft launch, a final inspection and acceptance of the GDHS occurs after a post-launch 30-day demonstration. The demonstration is described as follows:

- 30-Day demonstration. Following launch and orbit adjust, the 30-day demonstration is conducted. This is the last test performed and the objective is to show proper hardware, software, and personnel operation on an extended basis.

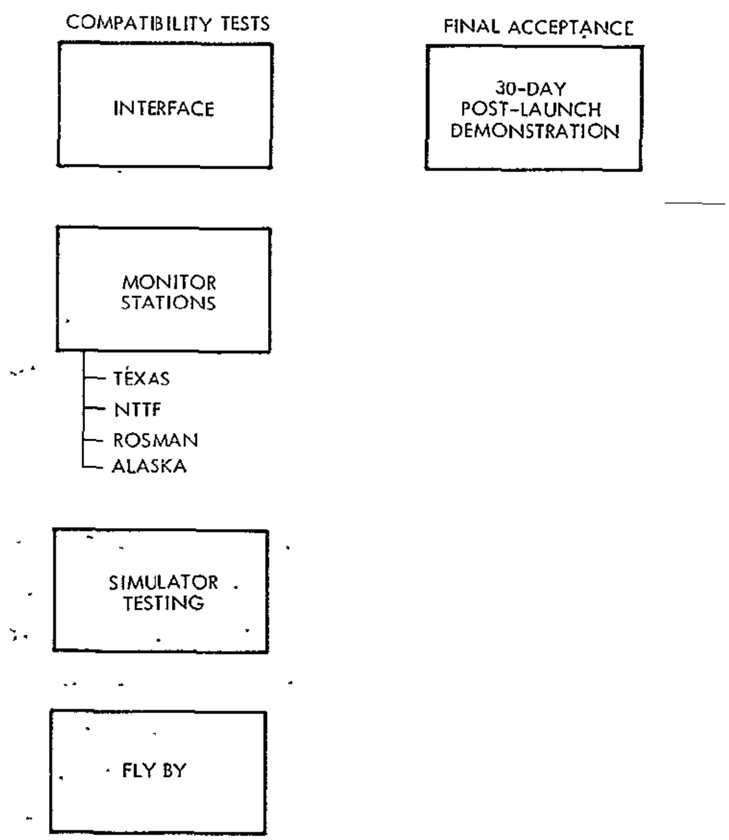

Figure 3-5. GDHS Integration and Test

4. DOCUMENTATION

4.1 INTRODUCTION

The first document prepared for the test program is the overall GDHS integration and test plan. This is subdivided into three plans: OCC, NDPF, and GDHS. These plans provide such information as a sequence of tests, test objectives and descriptions, test and retest criteria, and test schedules.

Based on the test plan which is approved by NASA, test procedures are written. The test procedures provide steps, sequences, and other details necessary for performing the tests. The test procedures contain values to be measured, including tolerances, and are used as a sheet on which to record actual measurements during a test. The record copy of all procedures is maintained and filed by the quality assurance inspector. In addition to the procedures a test log is maintained by the test manager as a means of documenting the continuous GDHS test history. A data package for each test is prepared and issued.

4.2 TEST DOCUMENTATION

The following documents are required for the test program:

- OCC test plan. For tests required in the TRW factory and at GSFC.
- NDPF test plan. For tests required in the IBM and Itek factories and at GSFC.
- GDHS test plan. For compatibility and interface tests of the GDHS at GSFC.
- OCC test procedures. For implementing the OCC test plan.
- NDPF test procedures. For implementing the NDPF test plan.
- GDHS test procedures. For implementing the GDHS test plan.
- Data packages. The compilation of documents associated with a completed test procedure. The package may also contain analysis of test results.
- Test log. A day-by-day history of the integration and test process.

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5. SPECIAL TEST EQUIPMENT AND SOFTWARE

Special test equipment and software consist of equipment or software developed exclusively for the test program. These may be retained by operations as maintenance tools after launch but primarily they are for use during the integration and test effort.

The following items of special test equipment are presently called for in the OCC:

- Interface boxes. Permits insertion of test points between any plug and its receptacle. These boxes are used together with test cables during most interface checks and during troubleshooting.
- Test patch panel. Provides test access to all inputs and outputs during integration.
- Modem 303 closed-loop test box. Permits closed-loop testing around modems.
- Computer simulator. Simulates computer interface for hardware, including input/output.

The above equipment is documented by sketch or photographs (with sufficient detail to permit building a similar unit with identical functional characteristics), is checked out with informal engineering test procedures, and is calibrated formally.

The test software is used during OCC hardware checkout with the computer prior to the availability of operational software. The following software is utilized:

- Test pattern generator for testing the display system.
- Data interface buffer echo check test software to test the ADPE/data interface buffer interface.
- Software to test the ADPE/PCM decommutator interface. Accepts simulated telemetry and displays data on the display system.
- Software to test the GMT timing data input to the ADPE.

The software is documented sufficiently to permit its use as a test tool during formal testing of the hardware.

NDPF will require diagnostic software for use during hardware subsystem checkout.

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6. TEST FACILITIES

6.1 INTEGRATION AND TEST FACILITY AT TRW

TRW will integrate and test the OCC in Building 74 of our central Redondo Beach facility (Figures 6-1 and 6-2). Building 74 was designed for electronic manufacturing, integration, and test and was selected for this task because it has an adequate amount of suitable space that can easily be modified to meet the integration and test requirements. The space required for ERTS is approximately 7000 square feet and this has been committed. TRW will simulate the OCC operating environment and to this end will modify the air conditioning, add a raised computer floor in the computer equipment section, make other necessary environmental and utility modifications, and provide office space. Figure 6-3 shows the OCC integration area and offices, including equipment.

TRW plans to use Building 74 for ERTS from January 1971 through August 1971, at which time the OCC will be transferred to the GDHS area on the east coast.

6.2 INTEGRATION AND TEST FACILITY AT IBM

The IBM factory in Gaithersburg, Maryland will be used as the integration and test facility prior to shipment to GSFC. An area specifically set aside for ERTS will be configured in a manner similar to that to be used at GSFC so that operational cables can be used during factory checkout.

Figure 6-1. Building 74, shown above, is a modern air-conditioned building. It is a part of TRW's central facility at Redondo Beach, Calif.

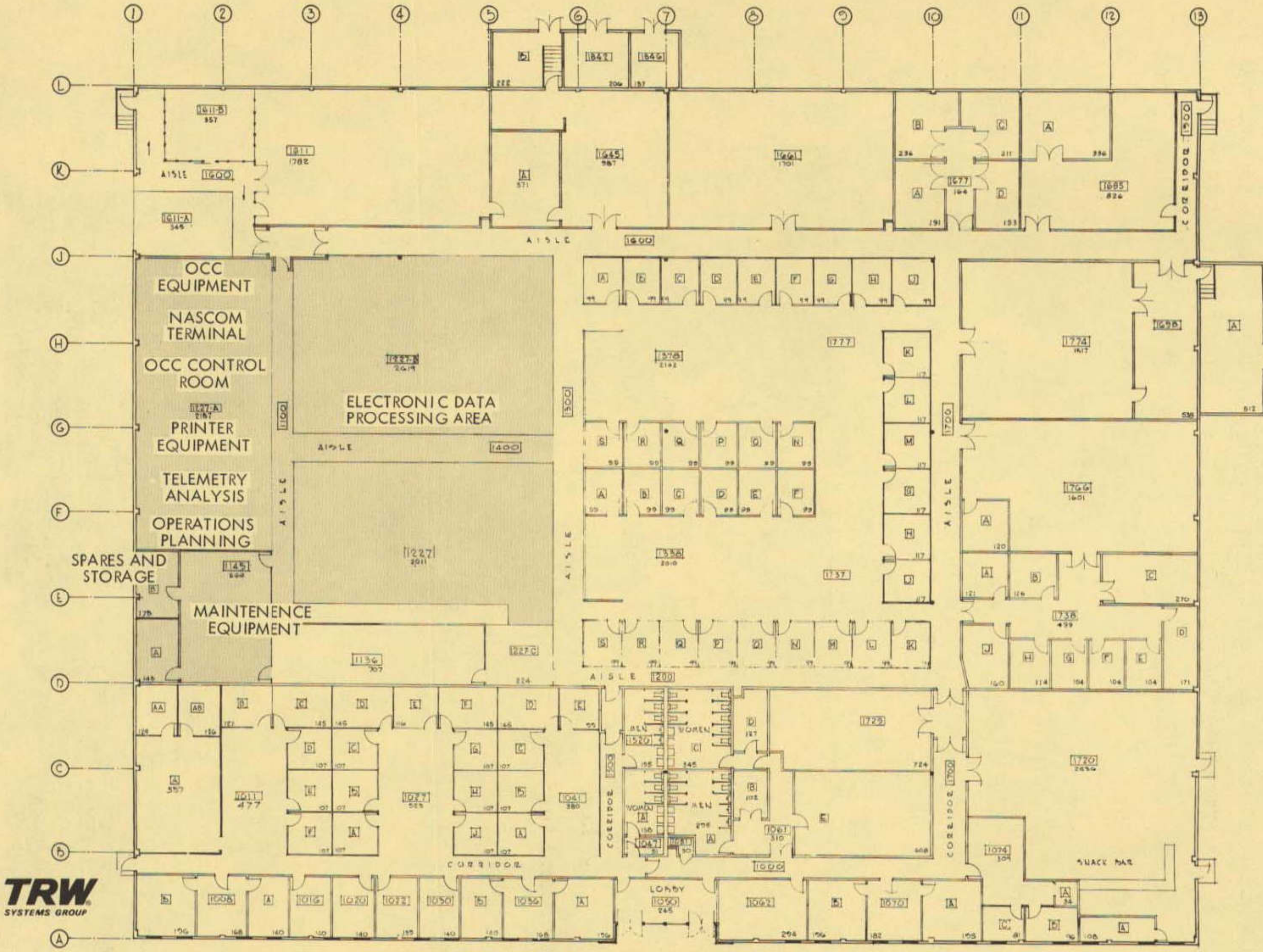

Figure 6-2. The shaded area in the floor plan of Building 74 is committed to integration and test of the OCC

FOLDOUT FRAME 1

FOLDOUT FRAME 2

FOLDOUT FRAME 3

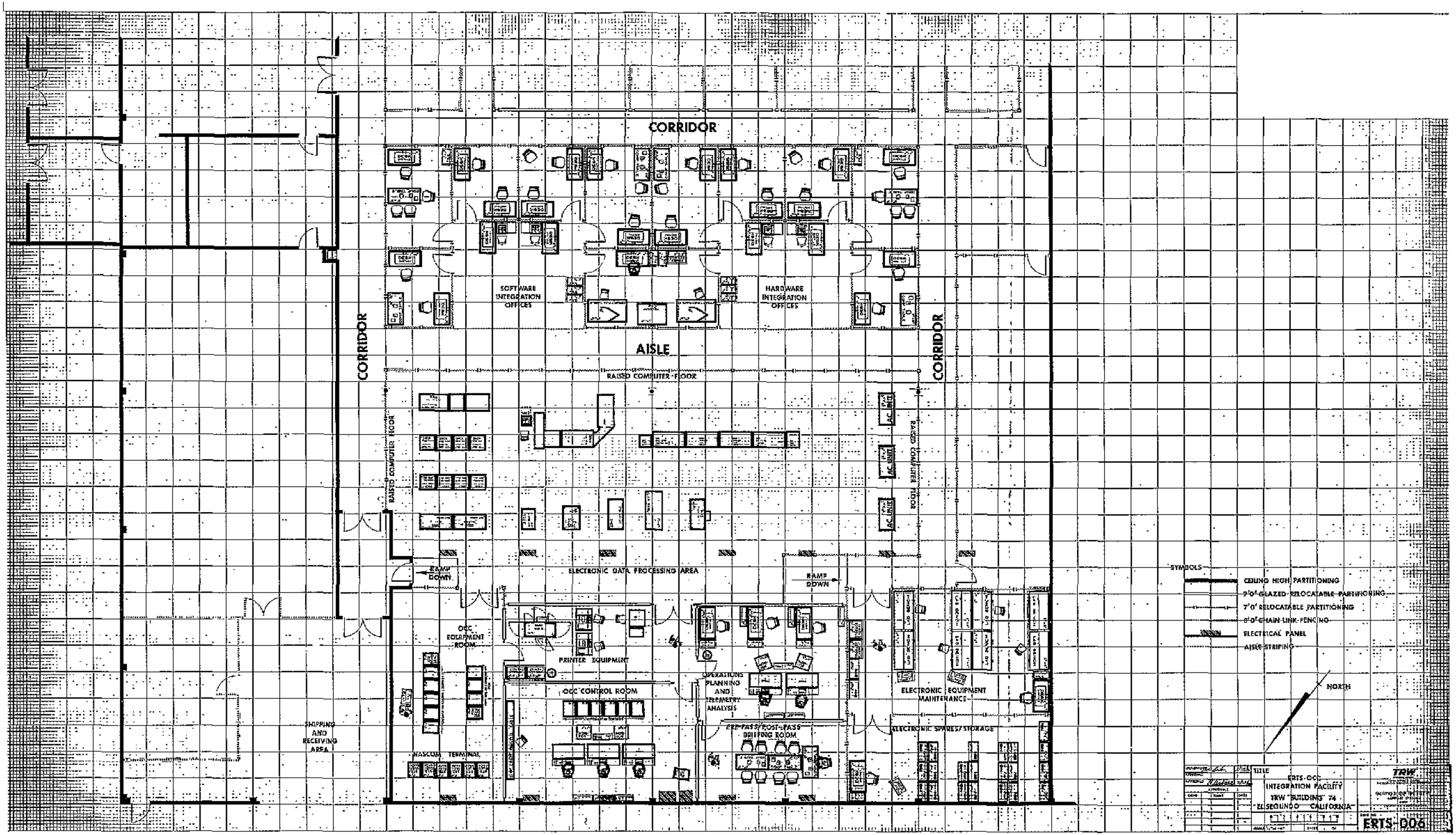

Figure 6-3. ERTS OCC Integration Facility